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# OCEANUS

OCEANUS

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VOL. X, No. 4, June 1964

# *Sails Sails Sails*

THE ocean will be studded with sails this year, (see Editorial page). Our cover shows the famous bark 'Passat' as photographed by Don Fay from the R.V. 'Atlantis'. The scene at left, taken by the editor during the 1962 Cup Races, will be duplicated many times this autumn as hundreds of yachts converge on Newport, R. I.

VOL. X, No. 4, June 1964

# 1964 A Nautical Year

THE ocean certainly will be in the news this year, but not so much for its water but for the ships upon it.

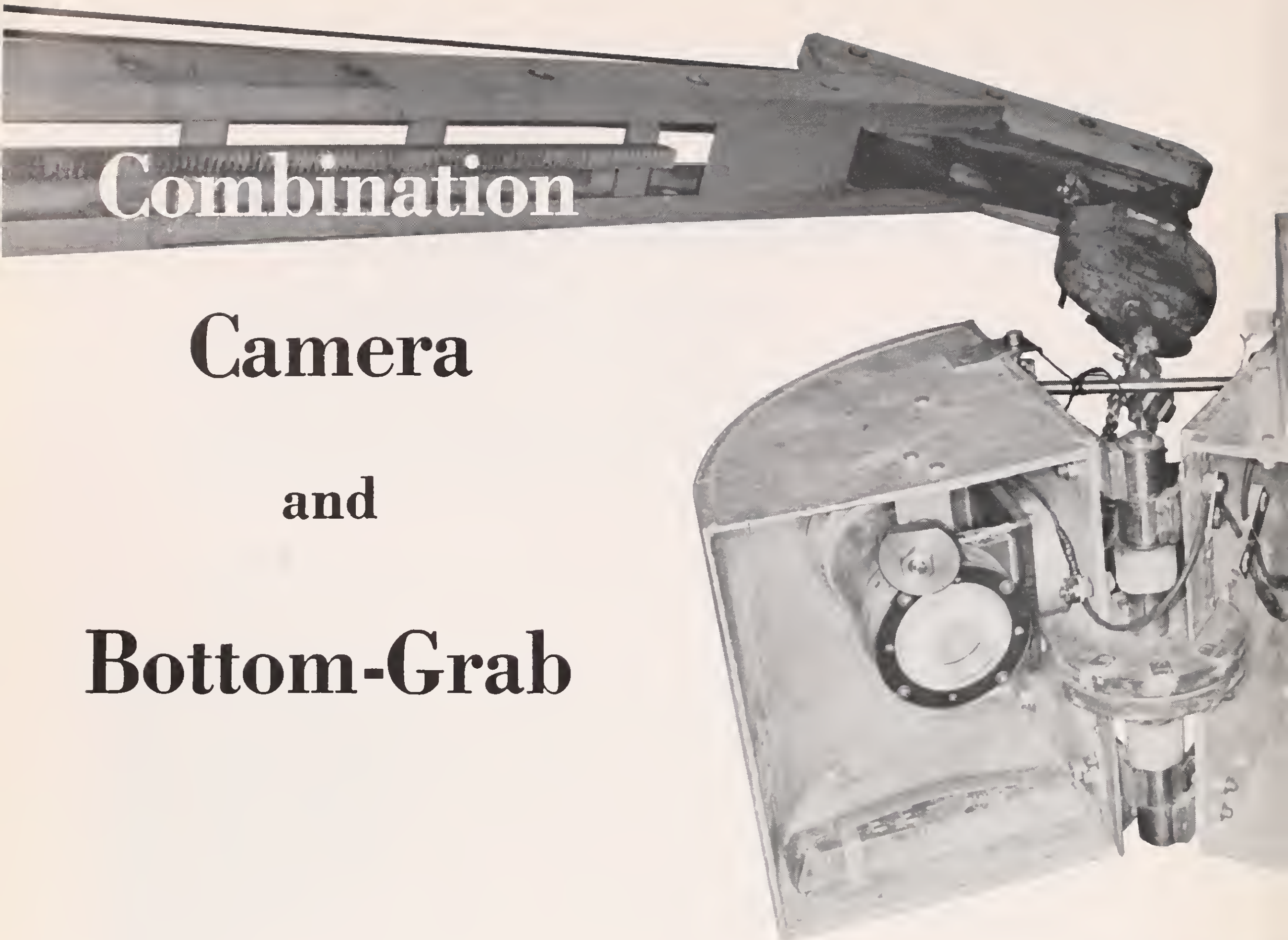
On June 20 some 140 yachts will depart Newport, R. I., for the biennial race to Bermuda. As usual we are providing suggestions on how to cross the Gulf Stream and, if possible, will have last minute information on the actual location of the current.*

Fourteen men left Plymouth, England on May 23rd each to race his own boat singlehandedly to Brenton Reef, R. I. That modern Joshua Slocum, Captain Francis Chichester, is the favorite and also was given information on the Gulf Stream.

But the biggest events of the year, for sightseers at least, will be the ending of the Transatlantic race for schoolships and the America's Cup Races. If wind and weather are favorable on July 14th, ships, barks, barkentines and schooners will sail single file through the Narrows in New York, a sight never to be forgotten.

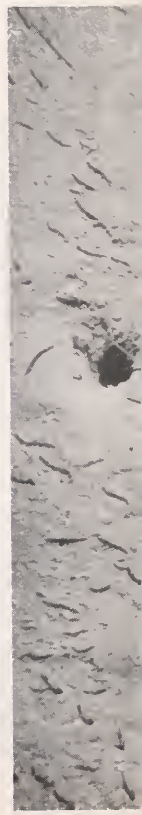
Alas, one sail will not be upon the ocean this year, The 'Atlantis' is not to be commissioned for the summer program.

*See also: "Information for the Bermuda Race," Oceanus, Vol. VIII, No. 4A. "How to get to the Ile of Devils", by Jan Hahn, Popular Boating, June 1964.

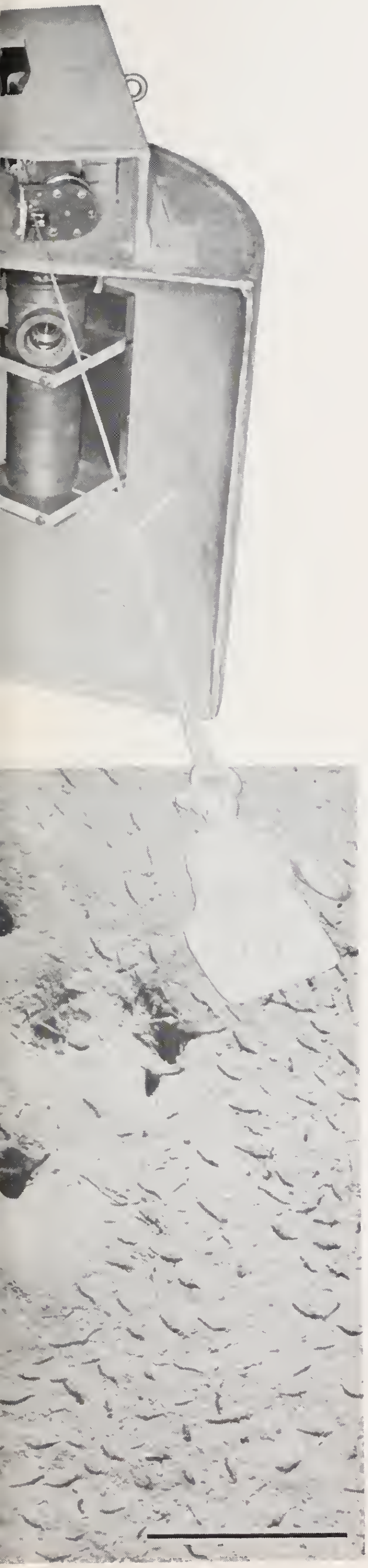


# Combination Camera and Bottom-Grab

**The identification of animals shown on bottom photographs has been a problem. A new system makes it possible to satisfy reluctant biologists.**



By K. O. Emery and A. S. Merrill



SINCE 1945 many thousands of good photographs of the sea bottom have been made but experience has shown that they are easier to make than to interpret, particularly for biological purposes. Most biologists are reluctant to identify animals and plants from photographs; they prefer to have the specimens at hand. Thus, the biologists cannot fully exploit the many existing photographs for distribution or ecological relationships. Several thousand large bottom samples have been obtained with dredges and grabs during the same period; however, the great distance between existing photographs and samples, coupled with the known patchy distributions of organisms, prevent the combining of data from specimens and photographs. Even when care is taken, photographs and samples cannot be taken reliably at the same spot on separate lowerings from anchored ships and certainly not from hove-to ships.

This difficulty has been solved by combining a bottom sampler as a source of specimens and a camera to view ecological relationships at the same site. The sampler is essentially a clamshell grab whose open jaws span an area of 0.56 $m^2$. A trip line below the grab activates the camera and light unit when the device has been lowered to about one meter above the bottom. After the film is exposed the grab continues downward to retrieve a large (as much as 0.2 $m^3$) sample of the same or essentially the same material which was photographed.

*Station 1234, southeast of Nova Scotia (43°10′.6 N.; 65°00′.0 W.) in 168 m. Brownish-green silty clay; sample contains 143 animals weighing 11.8 grams. Only polychaete worm tubes (probably Maldanidae) plus several large burrow holes can be seen in the photo.*

### *Camera-grab*

The original camera-grab was developed in 1961 by R. J. Menzies, L. Smith, and K. O. Emery at the University of Southern California using a Hasselblad camera and a flash bulb within a 250-kg (empty) grab designed and built by A. Campbell and used on the University's research vessel since 1954. At Woods Hole the device has been modified by D. M. Owen through substitution of a 35-mm Robot camera and a small stroboscopic light source. The area of bottom photographed is 0.48 m², 72% of which is between the jaws of the grab.

260 paired photographs and samples were obtained during 1963 aboard the R/V 'Gosnold' as part of a joint program between the Institution, the U.S. Geological Survey and the Bureau of Commercial Fisheries to investigate the continental shelf and slope off the United States east coast. Most of the lowerings have been off New England where bottom materials range from boulders through gravel and sand to clay. At least 80 per cent of the photographs are of excellent quality. Most of the pictures are black-and-white exposures but some are in color. The photographs on these pages were selected with the aid of R. L. Wigley and R. B. Theroux as examples of the different types of bottom materials and of the kinds of animals that inhabit such bottoms. Scale is indicated by a bar representing 10 cm on the sea bottom.

Bottom materials in the samples correspond closely to those in the photographs, with the exception that some bottoms consist of sand, silt, or clay smoothly covering gravel or boulders which are dug out and retrieved by the heavy grab. There is also a general correspondence of epifauna (surface life) in samples and photographs, but, of course, most of the organisms living in the sediment, the infauna, remain concealed. At some stations organisms too small to be seen in the photographs are the main constituent in the grab both in terms of numbers and of weight. Certain small amphipods and foraminifera are good examples; for instance, from station 1323 there was obtained an estimated one-third million foraminifera weighing 19.8 grams, and the total number of all other animals was 169 weighing only 14.2 grams.

**DR. EMERY**, geologist on our staff since 1962, is in charge of the cooperative program in geology mentioned in the text. Dr. Merrill, of the Bureau of Commercial Fisheries at Woods Hole, specializes in shellfish ecology and systematics.

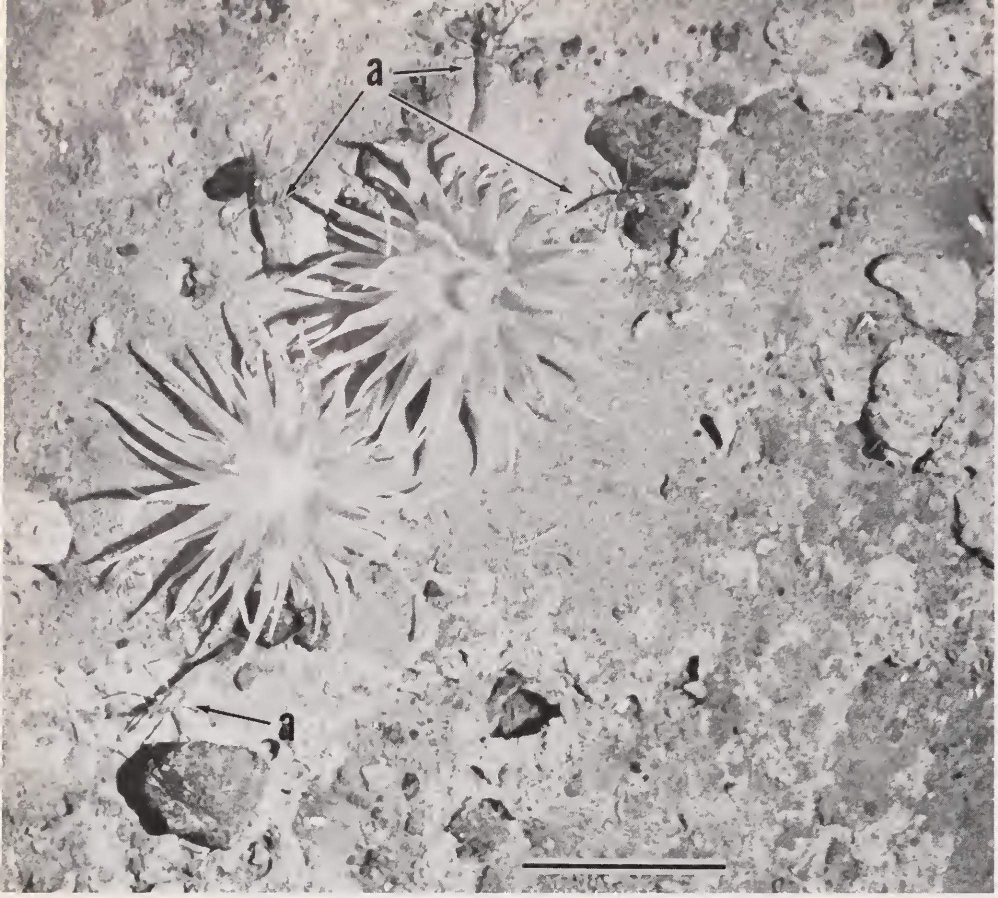
### Animal behavior

It is evident that geologists can make use of photographs which show animals that live only on particular kinds of bottom. Plotting the distribution of these species is tantamount to plotting known bottom types. Examples are the sand dollar, Echinarachnius, which lives on or slightly buried in sand, and the brittle star, Ophiura, which is restricted to silts and clays. Biologists can find such photograph-sample pairs useful for studying the behavior as well as the distribution of identified organisms. Two instances are illustrated by the accompanying photographs. The photograph at station 1061 reveals an association between the sea anemone and caridean shrimp. At station 1275 an instantaneous reaction of a sea scallop occurred when the trip weight struck nearby, but no such reaction is apparent at station 1052 where the organism is an anemone.

By 1966 we expect to have a total of about 1500 photograph-sample pairs on a 18-km grid throughout the entire continental shelf and slope between Key West and Nova Scotia. Study of these pairs should provide considerable new information in marine biology and marine geology.

*See also: Scheltema, R. S., "Deep Sea Biological Dredging", Vol. X, No. 2, and special issue on photography, Vol. VI, No. 1.

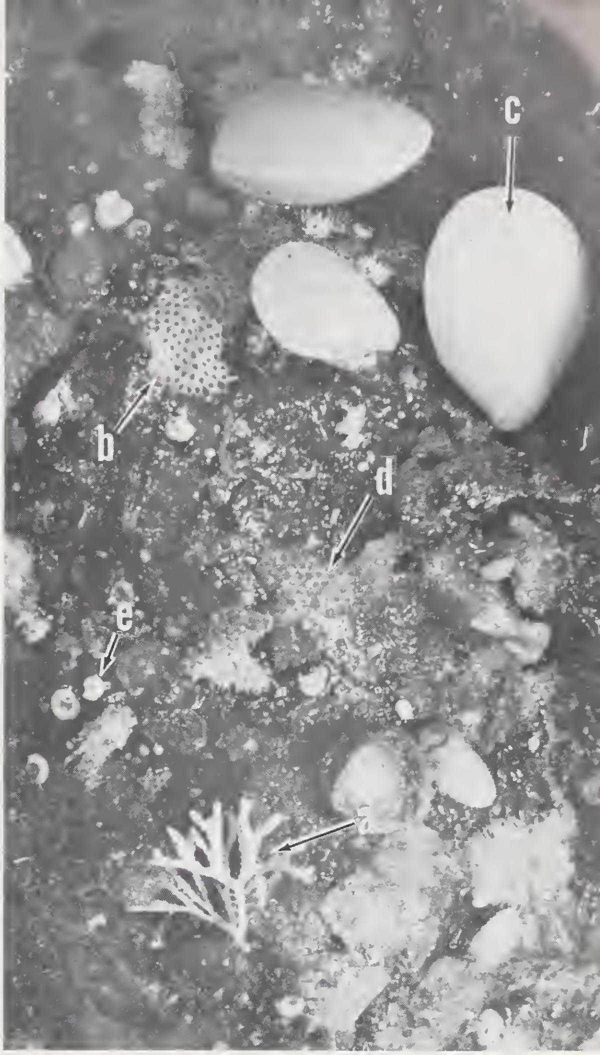
Station 1052, east of Cape Cod (42°10′.0 N; 69°13′.5 W.) in 200 m. Brown sand; sample contains 24 animals weighing 1.4 grams. Several tube dwelling coelenterates, Cerianthus, have their tentacles expanded naturally. Note to the right of the shackle on the trip weight the tube remains of a dead specimen of Cerianthus.




*Station 1061, southeast of Cape Cod (40°11′.0 N.; 68°29′.5 W.) in 507 m. Green-black Sticky clay, gray sand, a few angular pebbles (probably glacial till); sample contains 29 animals weighing 4.1 grams. Photo shows clearly two large sea anemones, Bolocera. Neatly camouflaged are several (a) caridean shrimp (Decapoda) facing outward from the anemones.*

*Station 1323, 40 km south of Hudson Submarine Canyon off New Jersey (39°20.′3 N.; 72°29′.5 W.) in 139 m. Greenish-gray fine grained poorly sorted slightly-silty sand; sample contains 169 animals weighing 14.2 grams. Note the following: (a) starfish, Astropecten, (b) sea pen, Pennatulacea, (c) heart urchin tests, Brissus, (d) holes probably made by sedentary polychaete worms.*

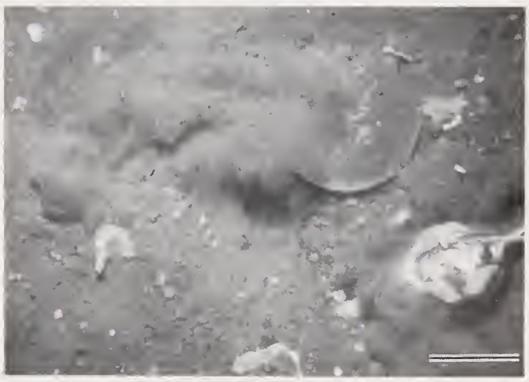

BRIGHAM, BUREAU OF COMMERCIAL FISHERIES




*Station 1235, southeast of Nova Scotia (43°10.′4 N.; 65°15′.3 W.) in 144 m. Gravel and boulders to 30 cm partly buried by silty clay; sample contains 153 animals weighing 62.4 grams. Bottom photo shows: (a) sea anemone, Cerianthus, (b) low flat sponge colony, Porifera, (c) sea anemone, Actinaria, (d) branching bryozoan, Tubulipora, (e) brachiopod, Terebratulina. Holes made by burrowing animals also are evident.*

*Close-up of faunal assemblage on a rock obtained in sample from Station 1235 (see bottom photo from same station). Photo was made in the laboratory after the animals had been preserved: (a) branching bryozoan, Tubulipora, (b) encrusting bryozoan, (c) brachiopods, Terebratulina, (d) gelatinous sponge, (e) serpulid polychaete worm, Spirorbis. (Photo is about 1½ times actual size)*

*Station 1275, south of Montauk Point, Long Island, New York (40°40′.2 N.; 71°45′.5 W.) in 59 m. Gravelly medium-grained brown sand; sample contains 116 animals weighing 53.4 grams. The sea scallop, Placopecten, disturbed by the lead trip weight snapped its valves together so quickly that water forced from it, stirred up sand on the bottom. Note arrow of compass which is embedded in the lead weight.*



# Oceanographic Forecasts

By C. O'D. ISELIN

*A recently published Atlas provides a wealth of information which may be used to aid in the routing of ships, the prediction of underwater sound conditions and other practical purposes.*

It is quite clear that a demand for objective oceanographic forecasts is rapidly developing. Routing ships across the ocean is but one of the practical objectives. There are also applications to fisheries management, to long range weather forecasting and to naval operations. As far as the currents are concerned, the starting point of a synoptic oceanographic forecast would be to store in the memory of a computer the tabulated values of temperature at a depth of 200 meters, the computer would then be programmed to calculate on the basis of the weather of the proceeding weeks how different from the average conditions the horizontal thermal structure would be during the forecast period.

### *Forecasts*

It was with this need in mind that Elizabeth H. Schroeder of our staff and her associates have over many years been compiling the basic data for such charts, which were recently published by the American Geographical Society as Folio 2 of the Serial Atlas of the Marine Environment, entitled "North Atlantic Temperatures at a Depth of 200 Meters." Besides being attractively printed in color, and using a very convenient projection, this publication summarizes the near surface physical oceanography of the North Atlantic and connecting seas. About half a million temperature observations were available to Miss Schroeder and a great deal of work on the part of many of our staff have been combined into a most useful and reliable set of nine charts which are available in loose leaf form on transparent paper or in a bound volume using excellent quality heavy paper.

The brief text accompanying these charts describes in detail the method of analysis, and the basic data for each one degree square of latitude and longitude are also tabulated. However, the author makes no attempt to explain the usefulness of these charts or to justify the very great labor involved in their preparation. While this will be quite obvious to most oceanographers, this article has been prepared to explain to non-oceanographers the significance and limitations of a plot of average temperature at 200 meters.

The depth of 200 meters was selected because throughout most of the area this is below the levels of significant seasonal changes in temperature. Thus, the data could be averaged for each one degree square of latitude and longitude regardless of season. Also, throughout most of the North Atlantic 200 meters is above the depths occupied by the permanent thermocline. Thus, temperature at this level is not much influenced by seasonal shifts in the position or transport of the deeper currents. This statement is not quite true as one approaches the equator where the top of the permanent thermocline rises to somewhat less than 200 meters.

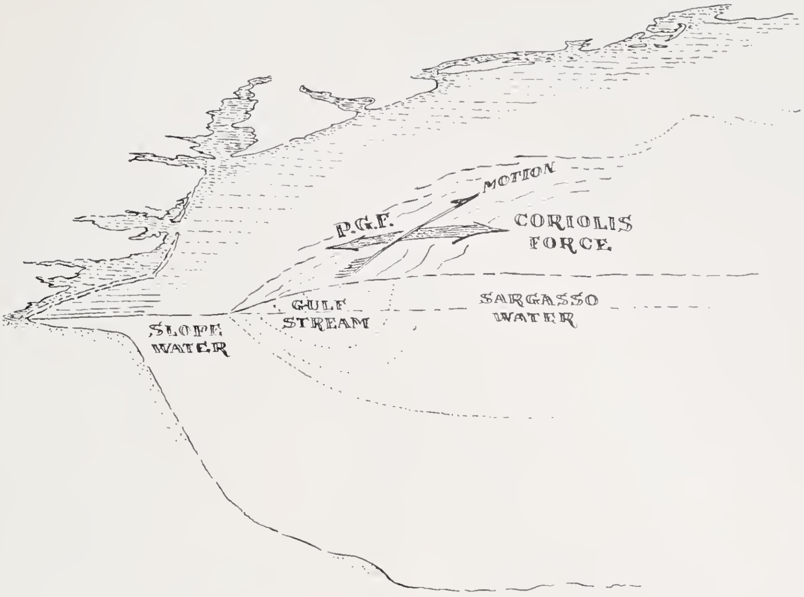
It is important to realize that briefly in winter north of about latitude 150°N the 200 meter temperature chart coincides with surface temperature. That is to say, during Maich when surface cooling, convection and winter storms obliterate the seasonal thermocline, the nearly isothermal surface layer will extend down to 200 meters or deeper.

### Thermal stability

At any other time of the year by subtracting the temperature at 200 meters from the surface temperature one can know the amount of thermal stability present in the water-column above the 200 meter level. Monthly charts of average surface temperature are readily available. Furthermore, if one knows what is called layer depth, that is to say the thickness of the nearly isothermal surface layer, one then has available three points on the temperature depth curve above 200 meters and in effect can reproduce this curve both seasonally and by area. Somewhat crude layer depth charts have already been published and more refined ones will be the subject of a future Folio of the Atlas under discussion.

The depth and intensity of the seasonal thermocline is an important biological parameter as well as being the single most important factor in the horizontal transmission of sound in the sea.

In the northern hemisphere along the left-hand edge of a permanent oceanic current (the observer having his back to the current) the isothermal surfaces in both the seasonal and permanent thermoclines are crowded together, that is to say, the thermoclines become more intense. This is because for a current to flow steadily and in a consistent direction there must be a cross-current pres-




*This bird's-eye view of the Atlantic coast north of Cape Hatteras shows how the pressure gradient force P.G.F. produced by the mass of warm light water in the Sargasso Sea is balanced by the Coriolis Force accompanying the motion of the Gulf Stream. The Gulf Stream can be regarded as fluid dam holding back the flood waters in mid-ocean.*

sure gradient operating to the left so as to balance the Coriolis force, as the effect of the earth's rotation is usually named, which otherwise would deflect the water to the right. Since the Coriolis force is proportional to the velocity, the isothermal surfaces are more crowded together in strong currents than in weak currents. At the 200 meter level the crowding together of a number of isotherms marks the position and intensity of the more or less consistent lines of flow. It is hardly an exaggeration to state that this series of 200 meter temperature charts is by far the best representation of the average, near surface permanent currents that has ever been published.

**Find currents**

Since the major ocean currents shift laterally in position, develop meanders and form large eddies, there are certain limitations to the averaging process when very large numbers of observations are combined. For example, the bundle of isotherms marking the mean path of the Gulf Stream System are more widely spaced than they would be during a short period such as a week or two. However, if one has means of observing temperature at 200 meters (for example, with a bathythermograph), one can find the axis of the current which will have a temperature value as shown by these average charts and then by adjusting course to follow this particular isotherm in the downstream direction one can gain the maximum help from the current when it is reasonably close to the desired course. Bulk cargo carriers such as tankers are beginning to learn how to do this and can sometimes increase their speed over the bottom by three to five knots. This is comparable to the help that high flying planes commonly experience by riding the atmospheric jet streams. Conversely, when traveling in the opposite direction it is equally desirable to avoid head currents and the charts in question also show you how to do this.

# 'Freak' Ocean Waves

*Exceptionally high waves are not curious and unexplained quirks of Nature. Their occurrence can be calculated with an acceptable degree of precision.*

By L. DRAPER

STORIES abound of monstrous waves; every sailor has his tale of how a great wave arose from nowhere and hit his ship leaving a trail of damaged lifeboats and shattered crockery. Estimates of the heights of the highest waves which can be encountered at sea vary widely. Cornish reported a freak wave 70 feet from crest to trough seen in the North Pacific in 1921, and waves of 80 feet and possibly higher in the North Atlantic in 1923. More recently, in 1956, Captain Grant of the cargo vessel 'Junior' reported a wave estimated to be 100 feet high about 100 miles off Cape Hatteras. There must be many more reports of similar waves in the history of the seas. As early as 1826 Captain Dumont d'Urville, a French scientist and naval officer in command of an expedition, reported encountering waves 80 to 100 feet high. The poor fellow was openly ridiculed for making such an outrageous report, even though three of his colleagues supported his estimate. Perhaps the most famous reliable report was that of the wave encountered by U.S.S. 'Ramapo' in the North Pacific in 1933; that wave was estimated to be 112 feet high, a monster indeed.

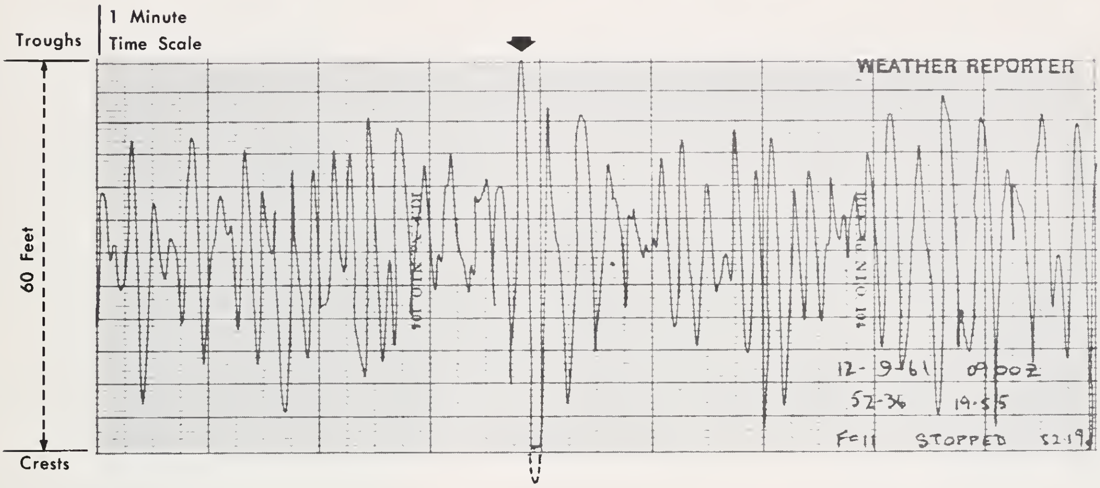
Although such events happen only rarely, this does not mean that their likelihood of occurrence is not predictable. There are two aspects of this problem. One concerns what happens on a sea when a large number of wave components each with its own period and height, are traveling along together at slightly different, but constant, speeds. As the components continually get into and out of step with each other they produce the groups of high waves followed by brief intervals of relatively quiet water which are characteristic of all sea waves. Every now and then, just by chance, it so happens that a large number of these components get into step at the same place and an exceptionally high wave ensues. The life of such a wave is

only a transient one, being not much more than a minute or two. Because each wave component is traveling at its own characteristic speed, the faster ones will escape from the others and the monster wave will die just as surely as it was born. The energy it contains belongs to its component wave trains, which still exist and travel on, taking their energy with them. Somewhere else in the storm at some other time some other wave trains will, again just by chance, coincide and produce another large wave which will have its brief moment of glory before disappearing forever into the random jumble of the sea. Although we are never likely to be able to predict just where and when an exceptionally high wave will appear, because the instrumentation problems involved are immense, the probability of occurrence of any such wave is finite and can be predicted; its calculation has the apparently contradictory title of Statistics of a Stationary Random Process. Using this theory, it has been shown that whilst one wave in 23 is over twice the height of the average wave, and one in 1,175 is over three times the average height only one in over 300,000 exceeds four times the average height.

The second aspect of the problem, also concerned with the prediction of the occurrence of exceptional waves, has a different basis. The probability of occurrence of unusual events such as severe storms, heavy rainfall, or hot summers, can be predicted by the Statistics of Rare Events. This technique has been used extensively by meteorologists in the study of natural phenomena and has proved to be a useful tool. The probability of occurrence of storms of any severity can therefore be calculated. From a series of recordings of wave conditions over a period of time such as a year, it is possible to estimate how often waves of any given size will occur by using these two methods. The longer the time over which the recordings have been made the more reliable will be the prediction.

**MR. DRAPER** is a physicist who, since 1953, has worked mainly on ocean waves at the National Institute of Oceanography in Great Britain.

It is only about thirteen years since it became possible to measure waves in the open sea from a ship with acceptable accuracy, and so provide a check on whether or not the stories of monstrous waves were to be believed. One of the British Ocean Weather Ships, operating in all weathers in the North Atlantic, has carried such a shipborne wave recorder for twelve years. As the ship is on station for about two-thirds of the time, the National Institute of Oceanography now has a long series of wave records which were taken for fifteen minutes every three hours. At first the scale of the instrument could record waves 50 feet high from crest to trough, but very soon it was found that waves higher than this were not uncommon and the scale was increased to 60 feet. This proved to be adequate for about nine years, but on September 12, 1961, 'Weather Reporter' lay close to the track of the dying hurricane Betsy, and as she made her routine recording at 0900 hours the pen dipped and touched the lower edge of the chart and then rose rapidly and "hit the stops" at the top — a wave over 60 feet high. A crest was fitted to this wave and it is estimated that the true height of the wave was not less than 67 feet from crest to trough. The period of this wave was 15 seconds, which meant that the weather ship was lifted over 60 feet in 7½ seconds and then dropped almost as far in the succeeding 7½ seconds! The probability that we actually recorded the highest wave which hit the vessel is fairly small, because the instrument is operated for only about 8% of the time. Using the first method described above one can compute that the highest wave which was felt by the weather ship during that storm was probably about 80 feet from crest to trough. At the present time the wave which 'Weather Reporter' measured is the highest one which




has ever been recorded by an instrument — conservatively estimated to be 67 feet from crest to trough.

Because the proportional area of an ocean which is occupied by vessels is incredibly small, it follows that only a minute proportion of the exceptional waves which must occur each year in an area such as the North Atlantic are ever noticed by man. It therefore seems reasonable to suppose that with only one vessel equipped with a wave recorder regularly at sea in the North Atlantic, the chance that our 67 foot wave is the highest which ever occurred is small indeed. We must by no means claim that the report from the 'Ramapo' was exaggerated.

Although one is inevitably surprised when an exceptional wave appears to rise from an apparently ordinary rough sea, and everyone who sees or feels it labels it as a freak, it is fair to say that no miracle is being witnessed; the chance of this occurring does seem to obey well established physical laws, so that the probability of occurrence of a wave of any specified height, or the probable height of the highest wave which will occur in any specified length of time, can be calculated with an acceptable degree of precision. After all, the latter problem is raised by every good engineer who hopes to build a structure in the sea, and oceanographers are expected to provide the answer!

*Four days after birth. Great masses of ash and clouds reached thousands of feet into the sky.*

# A NEW VOLCAN

*The formation of new islands is not a rare occurrence in the ocean. Since 1950 several islands were formed off Japan and in the Azores group; a new island appeared near Iceland in November, 1963 — and was named Surtsey, after the God Surter, the Icelandic equivalent of Hephaestus, called Vulcan by the Romans.*

By D. C. BLANCHARD

ON the 14th of November 1963, volcanic explosions burst through the surface of the sea about 20 miles off the southwestern coast of Iceland. The explosions continued and great quantities of ash and cloud were thrown up. The falling ash rapidly built up an island of considerable size.

Late in January of 1964, two research flights were made to Iceland. The object was to investigate the various phenomena that were associated with the eruption of Surtsey, as the island was named. In company with several other scientists, I was aboard the second flight that arrived in Iceland during the second week of February. Mr. Hughes of the Office of Naval Research, who was instrumental in the initiation of the flights, Mr. Charles Moore of Arthur D. Little, Inc. and I left the plane at

# IC ISLAND

BLANCHARD

*In the wild cauldron of smoke, ash and "firebombs" a strange waterspout appeared connecting two cloud masses. At times tornados were almost continuous over the island.*

Keflavik and made our way south to a tiny island with the not-so-tiny name of Vestmannaeyjar. As this island lies only about 12 miles from Surtsey, we intended to use it as a base for photographic and other observations. Most important of all we hoped to charter a local fishing boat and make a trip to within a few hundred feet of Surtsey. We were interested in obtaining data at close range on the lightning and other electrical phenomena that had been observed in the vicinity of the volcano.

The fishing boat 'Haraldur' was chartered and Mr. Moore put instruments aboard to measure the atmospheric potential gradient and point discharge current. After a number of days of bad weather, the winds dropped and we were able to make the sea trip to the volcano. By this time Surtsey was three months old but the eruptions were still frequent. The island was nearly circular, about 3,000 feet in diameter and 500 feet high.

We approached from the upwind side and when we arrived Surtsey put on a magnificent display of the forces that she had at her command. The eruptions were occurring from a crater that was near the edge of the island and partially open to the sea. The contact of the cold sea water with the hot pumice or lava (it was impossible to tell the nature of the material) appeared to be the cause of giant explosions that sent geysers of ash-streaked cloud and water hurtling upward to heights of over a thousand feet. Cloud masses continued on upward until at times there was a long cloud column that extended from near the sea to altitudes of 20,000 feet. In the lowest thousand feet of the column there was frequent lightning and thunder; our instruments recorded the electrical activity.

The most intense part of the eruption was comparable to a giant three-ring circus; so many things occurred at the same time that it was impossible to take them all in. In addition to that described above we could see huge rocks or fire bombs that were thrown out of the main plume. These would follow an arching trajectory through the air to crash back into the island or splash into the sea. Numerous mushroom-like clouds and smoke rings could be

seen and from the lower parts of the plume a waterspout was often visible against the dense curtain of ash that fell in long streamers back into the sea.

From the point of view of learning something about the nature of the electrical activity our trip to Surtsey was certainly worth while. Although I cannot speak for the others, I am of the opinion that at least a part of the electrification of the atmosphere by the eruption is caused by a charge separation that involves the contact of sea water with hot material from within the earth. I have carried out simple experiments with molten lava and sea water that demonstrate this mechanism (**Nature**, 201, 1164, 1964), and in view of our findings at Surtsey I plan further experiments along this line.

It appears to me that Surtsey is providing an ideal outdoor laboratory for studies in many areas of research. Investigations might profitably be started on other meteorological problems. For example, it would be of interest to look into the subject of atmospheric hazes formed by volcanoes.* The interaction between the volcano and the sea might be of interest to the biological, chemical, and physical oceanographer. It may well be that from studies at Surtsey and other similar marine volcanic eruptions much can be learned about what happened millions of years ago when the interaction between sea, volcanic material, and air was proceeding at a much higher rate of activity than we observe today.

*See: "Lava and the Sea", A. H. Woodcock, Oceanus, Vol. 6, No. 3.

## New life on new volcanoes

A PROGRAM has been initiated at Duke University to study the introduction and spread of flora and fauna on the new volcanic island, its underwater slope and the nearby seabottom.

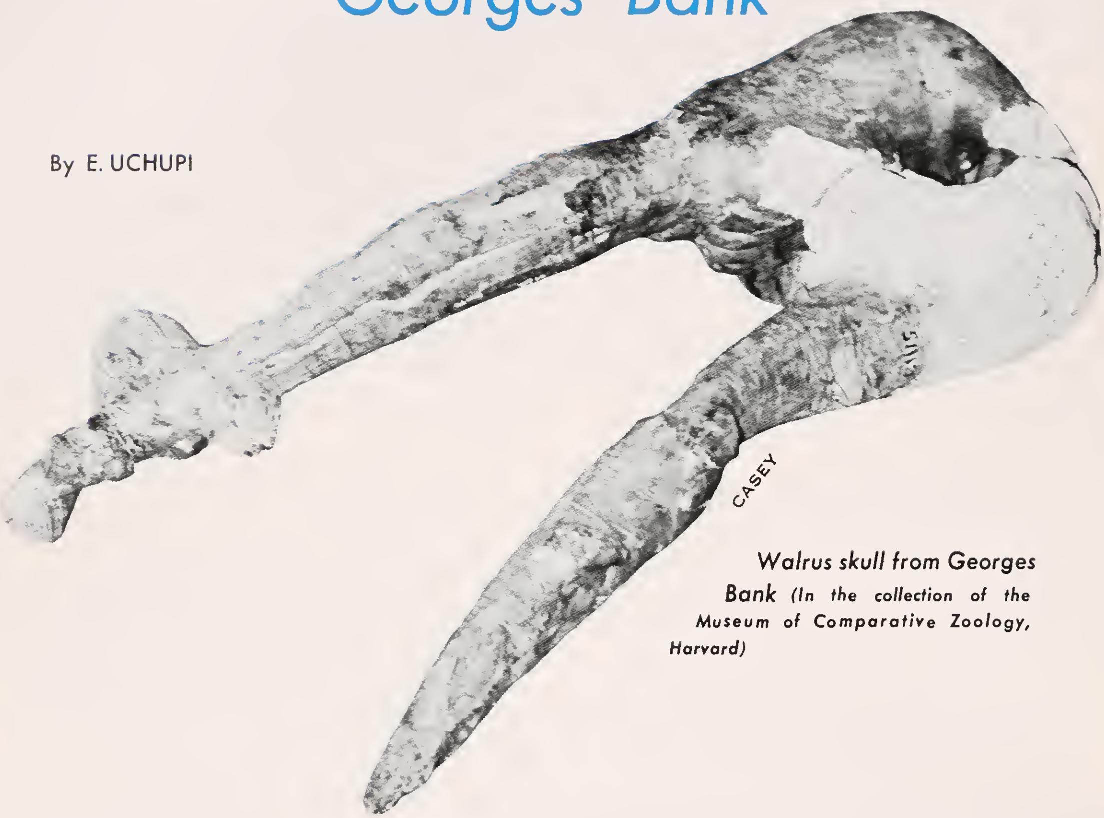
The introduction of life on the huge ash heap may take some time. In late April the editor visited 'Capelinhos', the volcanic island which became attached to Fayal in the Azores during 1958. Sloshing about up to our ankles and sometimes up to our knees in the ash we found no obvious evidence of plant or animal life.

**DR. BLANCHARD,** meteorologist on our staff, is interested in the transfer of electrical charges between the ocean and the atmosphere. His graduate studies were done with the aid of an Associate Fellowship.

*Ash and solidified lava on Capelinhos volcano, Fayal.*

# Unusual hauls from Georges Bank

By E. UCHUPI




*Walrus skull from Georges Bank (In the collection of the Museum of Comparative Zoology, Harvard)*

*Mastodon teeth, the bones of whales and teeth of fossil sharks are found one hundred miles off the Cape Cod shores.*

FOR MORE than a century fishermen on Georges Bank, about 100 miles east of Cape Cod, have brought up unusual hauls along with the more edible catch. Rocks weighing hundreds of kilograms are found frequently and the nets are sometimes ripped, presumably by even larger boulders. The boulders are predominantly igneous and metamorphic in character, although occasional fragments of limestone and other sedimentary rocks are recovered. The metamorphic and igneous boulders are believed to have been transported from the mainland or the Gulf of Maine by Pleistocene glaciers, but the sedimentary blocks, some of which contain fossils ranging in age from Cretaceous to Pliocene, may be from outcrops on the banks.

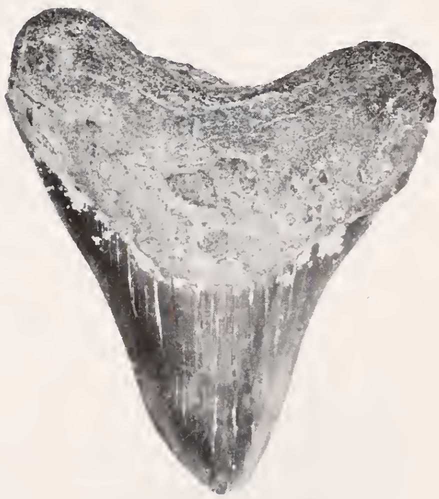
Whale bones, shark teeth, mastodon teeth, and walrus bones have also been recovered from this area. In 1928 the steam trawler 'Mariner' dredged a badly weathered walrus rostrum with the two tusks as well as most of the flat-crowned crushing

teeth of the upper jaw still in place. In 1941, a walrus skull with the left tusk still in place was recovered from the bank by a fisherman. At the present time the Atlantic walrus, **Odobenus rosmarus rosmarus,** is found mainly north of Davis Strait, but in historic times it has been reported as far south as Sable Island off southern Nova Scotia, and probably it penetrated into the Gulf of Maine. During the Pleistocene, the walrus extended as far south as the Carolinas. The only recorded instance of the appearance of a walrus in the Cape Cod region was in December, 1734, when the Boston Weekly Rehearsal issue of that month ran the following advertisement:

> **"To be seen at the Shop of Mr. Benjamin Runker Tinman near the Market House on Dock Square a very Strange & Wonderful Creature called a Sea Lion lately taken at Monument Pond near Plimouth, The like of which never seen in these Pari[=t]s before. He is Nine Feet long from His Rump to his Head & near four feet wide over his back with Four Large Feet & Five Strong Claws on Each. Also Two Large Strong Teeth as white as Ivory out of his mouth five or six Inches Long . . . Price Sixpence for a Man or Woman & 2 Pence for a child."**

A more intriguing problem is how did the remains of a mastodon, a land mammal, get to Georges Bank? Were they transported from the mainland by the same glaciers that deposited the erratic boulders atop the bank? Or was the tooth found at or near the spot where the mastodon died? If the mastodon died there, it probably migrated into the area during one of the lower sea level stands in the Pleistocene when the continental shelf and Georges Bank were exposed. Similar migrations to the continental shelf during the Pleistocene also occurred in southern California. At that time some of the islands off the southern California coast were connected with the mainland and elephants and other land mammals migrated across the exposed shelf.

*A mastodon tooth is shown proudly by the crew of a New Bedford scalloper.*



*Fossil shark tooth. About 10 cm long. Its former owner was estimated to have been 10 meters long.*

*Fossils*

The specimens shown in the other photographs were obtained by Mr. Charles J. Loan of Fairhaven aboard the fishing vessel, 'Sippican'. In the same haul along with the vertebrate remains were well rounded igneous and metamorphic clasts and at station B a sandstone boulder was found containing many scallop shells of Tertiary age. The phosphatized* shark's tooth tentatively has been identified as coming from **Carcharodon megalodon,** which has a stratigraphic range extending from the Cretaceous to the Pleistocene. From the size of the tooth the shark must have been about ten meters long. The bone fragments shown in the other photographs are believed to be from whales, and with the exception of the large vertebra from station C all are phosphatized.* Dr. F. C. Whitmore of the U.S. Geological Survey believes that the fragments from station A came from a Miocene baleen whale. The rib from station B and the phosphatized fragments from station C are probably also Late Tertiary or Pleistocene in age, and the large vertebra from station C may be Late Pleistocene or Recent.

*Phosphatized whale bones. Dr. F. C. Whitmore of the U.S. Geological Survey believes that they are from a Miocene baleen whale. The jaw bone fragment is about 29 cm long. These specimens were recovered at station A (Lat. 41° 51.0′ N, Long. 67° 22.5′ W, depth: 50-55 meters).*

* The tooth's original composition has been changed to phosphate rock.

**DR. UCHUPI** joined our staff in 1962 and is working on the continental margin geology studies. (See page 3).

## Still in the soup!

WE poked a bit of fun at the spreading use of initialized organizations in the last issue of Oceanus. We have learned that a list showing some 110 abbreviated organizations dealing with marine science was compiled by the BCF Biological Laboratory, Washington, D.C. If anyone wants the list perhaps Thomas Austin will comply. Ask for General Memorandum 12-63.

# Recent Books

Books on oceanography are coming off the press in ever increasing numbers. We list a few of the recent arrivals.

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*R. Wyler and G. Ames, "Planet Earth", Golden Press, New York, 1963. $3.95*

A fine children's book, includes "The world of water"; for elementary and Jr. High School grades. With extremely clear and clever color illustrations by C. de Witt.

•

*A. Montagu and J. C. Lilly, "The dolphin in history", Wm. A. Clark Memorial Library, U. of California, Los Angeles, 1963.*

Whether or not one agrees with all that has been said and written about dolphins (porpoises) recently, the amusing re-telling of ancient knowledge proves once again that it pays to give attention to the past. The Greeks knew about it all along!

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*Not so recently received but worth attention:*

*J. Spar, "Earth, Sea and Air". Addison-Wesley Publishing Co., Inc., Reading Mass., 1962. $2.95 hardbound, $1.95 paperback*

For the student, the layman and not so layman this small (142 pp) book provides a lucid description of the solar system, and the earth as a planet with its lithosphere, hydrosphere and atmosphere. A fine reference book for Oceanus readers. Available in hardboard or paperback.

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*I. Hela and T. Laevestu, "Fisheries hydrography", (How oceanography and meteorology can and do serve fisheries). Fishing News Ltd., London, 1961. £2/17/6*

This book only recently came to our attention. As the subtitle indicates it ought to be much better known, particularly with the increasing interest in practical oceanography. The smart fisherman and industry interested in increasing the catch or providing instruments and other means to the fisheries ought to study this book carefully.

*G. Dietrich, "General Oceanography, an Introduction". Interscience publ. John Wiley & Sons, N. Y., 1963. $20*

This is the English translation of the excellent German textbook.

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*H. and G. Termier, "Erosion and Sedimentation". The University Series in Geology, D. van Nostrand Co., Ltd. London, 1963. $11.75*

English translation by R. W. and E. Humphries. Intended for the student and the young geologist, this interesting and readable book perhaps will perform its most useful service as a refreshing review and a source of reference for workers in the field.

W.D.A.

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*A. C. Robinson (Editor), "Wind driven ocean circulation," Blaisdell Publishing Co., New York, 1963. $3.75*

A collection of eight previously published theoretical studies on the relation of permanent ocean circulation to the distribution of mean atmospheric winds.

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*D. M. Ludlum, "Early American Hurricanes, 1492-1870". Am. Meteor. Soc., Boston, Mass., 1963. Paper: $5. Cloth: $7*

This first volume of a projected series on the history of American weather contains a wealth of interesting reading. The book is dedicated to William C. Redfield (1789-1857)—the great grandfather of our Dr. A. C. Redfield—who initiated the scientific studies of American hurricanes.

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*N. L. Peter, "Weatherwise, the Technique of Weather Study". A Pergamon Press Book, The MacMillan Co., N. Y., 1964. $3.50*

Written for use in schools and for the amateur yachtsmen this pleasant little book is a fine introduction to meteorology and forecasting. To the best of our knowledge this is also the first of its kind to pay a great deal of attention to the interaction between ocean and atmosphere.

# Associates' News

THE annual dinner meetings of the Associates took place in Wilmington, Delaware, New York City and Boston, Mass., and were well attended by Associates, their friends and prospective associates. Mr. A. R. Miller, chief scientist on the Indian Ocean Expedition of the 'Atlantis II' (See: Oceanus, Vol. X, No. 3) was the principal speaker. The Editor regrets that he was unable to attend as he was at sea.

## In Memoriam

We deeply regret the death of Rachel Carson on April 14th. Miss Carson was a member of the Executive Committee of the Associates since the inception of the program.

"The Sea Around Us" will stand forever as her monument.

## Cooperative game fish tagging program

PROOF that white marlin migrate from off Delaware to the West Indies and live for a considerable time after tagging was obtained recently. One fish was tagged by Capt. Howard T. Waller of Delmar, Delaware, 40 miles northeast of Ocean City, Maryland in August 1963. Four months later the white marlin was recaptured 25 miles west of St. Vincent, in the Windward Islands. The fish swam at least 1700 sea miles in 124 days. Apparently, this is the longest migration known for the species. (See: F. J. Mather, "Game Fish Migrations", Oceanus, Vol. X, No. 2)

Another white marlin tagged in August 1962 off Ocean City, Md., was captured two miles north of Cojimar, Cuba, 591 days later. The Cuban Academy of Sciences which reported the catch stated that the marlin was 86 inches long and weighed 55 pounds.

When two Russian research vessels entered Boston in April they were visited by a delegation from Woods Hole. Here, our Director Dr. Paul M. Fye chats with Academician Leonid M. Brekhovskikh (center) and Dr. Feodor Ivanovich Kryazhev (left). The ships were the 'Sergei Vavilov' and the 'Petr Lebedev', both converted freighter-passenger vessels.

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## Articles



## Features



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